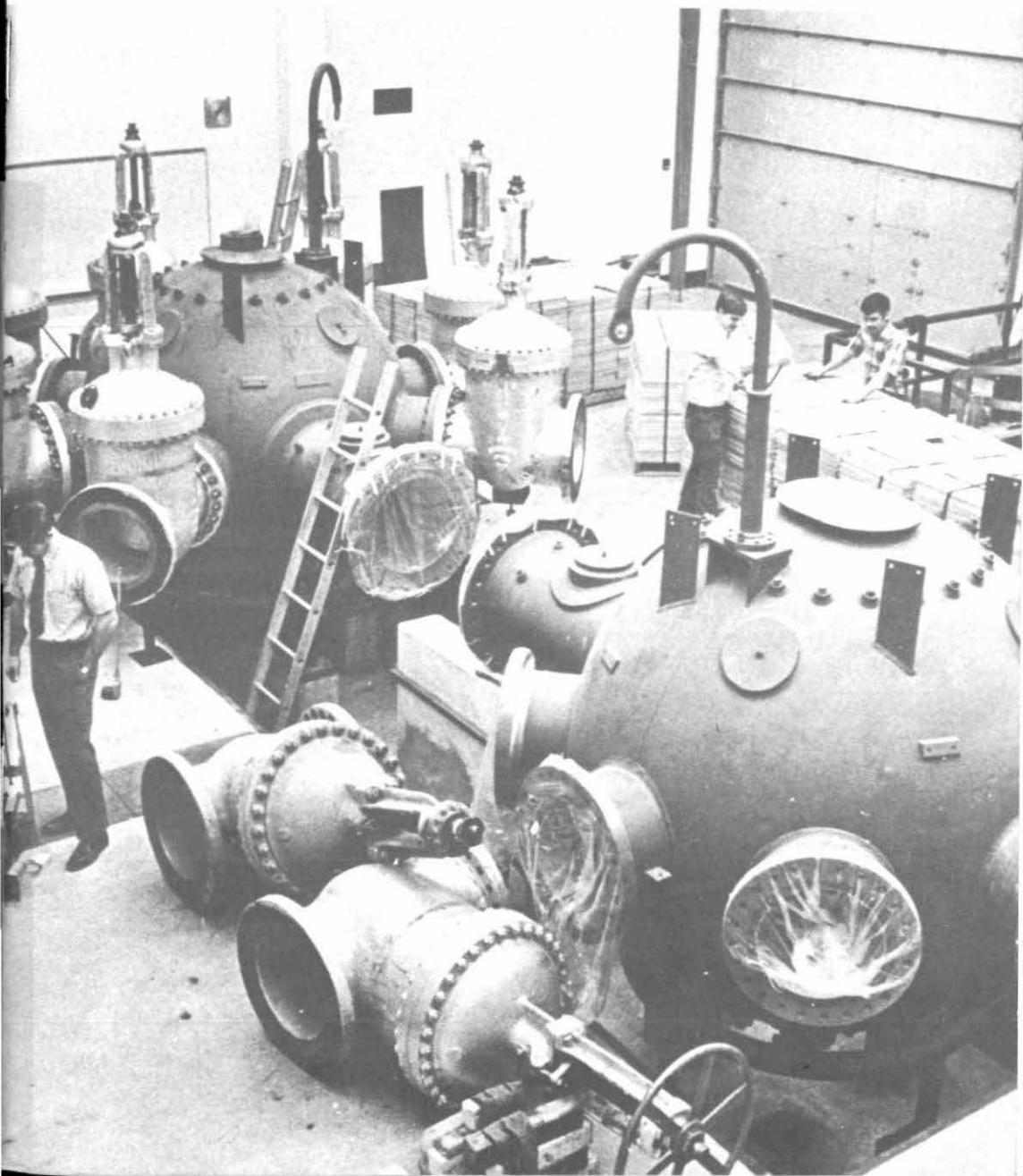


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Cover Caption

The major component of the High Pressure Life Laboratory consists of two seven-foot spheres surrounded by seven animal living chambers.

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Man-in-the-Sea Project in North Dakota

"There is no other laboratory like this elsewhere in the world that can do the type of research that will be conducted here. This is an automated laboratory in which a computer precisely regulates the atmosphere, including temperature, humidity and pressure as well as recording a variety of physiological data. The animals can be placed in an environment similar to the ocean depths as deep as approximately 1300 feet for days, months or years, with food provided and waste removed by remote control."

The above remarks are from the address made by the Chief of Naval Research, RADM Van Orden at the dedication of the High Pressure Life Laboratory, University of North Dakota, Grand Forks, North Dakota, November 30, 1973 (Figure 1).



Figure 1 – RADM Van Orden examining some experiment results with Dr. Thomas K. Akers, Project Manager of the Man-in-the-Sea Project

The Project

Research into the effects of undersea submersion at depths to 1,300 feet is the prime aim of the Man-in-the-Sea Project at the University of North Dakota. It is one of the largest and most advanced research projects of its kind and has the only high pressure life laboratory in the free world capable of studies of the long-term effects of high pressure on the reproduction, nutritional needs and general health of test animals.

Planning and experimentation for the Man-in-the-Sea Project have been under way since 1968. The research project already has produced nearly 80 scholarly papers, dissertations and theses. It is funded by the U.S. Office of Naval Research, and is staffed by University faculty and student researchers from several academic disciplines.

Man-in-the-Sea research deals with a broad spectrum of problems associated with life under high pressure and has wide-ranging possibilities for application. Knowledge gained from the research will be important in developing ways for man to live under the sea for prolonged periods to recover the food and energy resources found there.

The research also promises to aid medicine by explaining the reaction of the human body to various gases, bacteria, drugs and other substances under pressure. Further application of knowledge derived from the project extends to military and defense needs of the country.

Some areas for expanding research that will result from the Man-in-the-Sea Project were mentioned by RADM Van Orden.

"We must remember that the ocean is an essential and major part of the world in which we reside. For the Navy it is the environment in which we operate constantly, and we must understand it fully to benefit from the advantages it offers and, at the same time, protect our men from its dangers. Aside from its military use, the ocean offers answers to some of man's most serious problems. Off-shore oil could certainly help in reducing our oil shortages. Some wells are being drilled as deep as 350 feet. Valuable minerals, such as manganese, cobalt and nickel, can be taken from the ocean floor. Even diamonds can be dredged from the ocean bottom and have been for several years off the coast of Africa. Most important of all, the 60 million tons of fish and shellfish now obtained from the sea each year world-wide could be increased to one to two billion tons per year if instead of hunters we became harvesters of the sea through fish farming. Japan already has had some success in doing this."

"Before we can begin to experiment with man himself, however, several biomedical questions must be answered in an animal laboratory such as this one. What is the effect of

breathing inert gases over such long periods of time? Should we continue to use helium or should we switch to the only lighter gas hydrogen? What are the effects of living so long in remote isolation under constant stress? What type of food is needed to provide adequate nutrition?"

The major component of the High Pressure Life Laboratory, measures 40 feet long, 20 feet wide and nine feet high and consists of two seven-foot spheres joined by a passageway with a 24-inch gate valve. Each sphere is surrounded by seven 18-inch animal living chambers separated from the main sphere by 18-inch gate valves. To facilitate prolonged study under constant pressure, animals can be transferred to the spheres while the living chambers are decompressed, cleaned and resupplied (Figure 2).

Construction of the test facility became possible when the Office of Naval Research made available as Government Furnished Equipment some 15 pieces of machine tools and welding equipment. The ability of the University to machine and fabricate in-house almost all major components resulted in a laboratory that would cost several million dollars more if constructed by industry. In addition, items of electronic

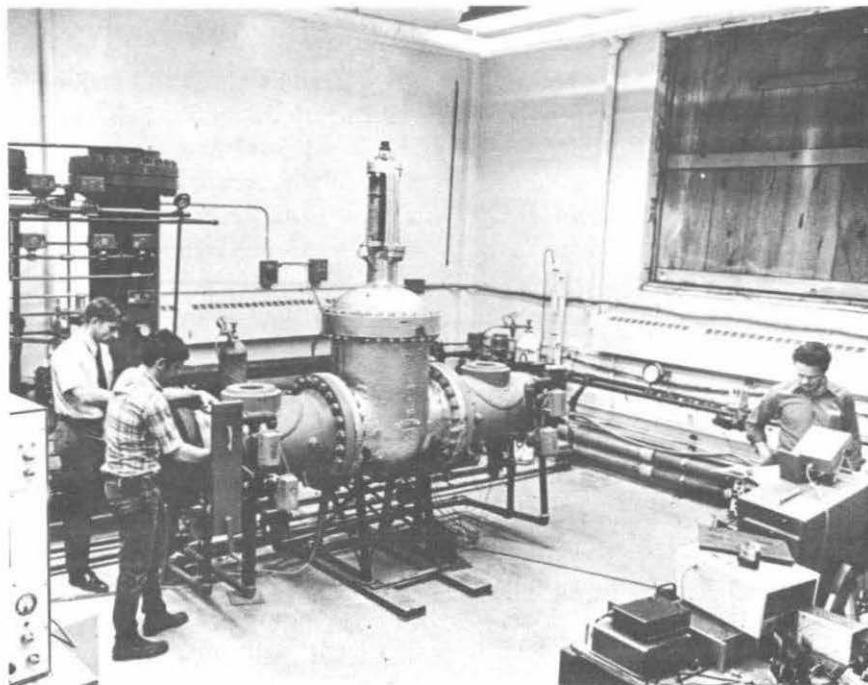


Figure 2 — Fabricating one of the animal living chambers at the machine shop

systems and laboratory instruments obtained from Government excess have greatly facilitated the research program.

Pressures of up to 40 times that experienced on the earth's surface or a depth of 1300 feet can be maintained in the chamber complex. Research calling for exposure to high pressure for prolonged periods of up to two years of more is planned (Figure 3).

The History

In 1967, the Department of Defense initiated Project Themis as a means of developing centers of excellence in universities throughout the country. The University of North Dakota recognized that, following the Navy SEALAB experiments, there were still problems to be solved before man could live at deep depths for very long periods, and the solution to these problems had to start with animal experiments. They formed a team that created a successful proposal that brought about the establishment of the hyperbaric center. Thus began the long collaborative efforts between The University of North Dakota and the Office of Naval Research to develop the High Pressure Life Laboratory.

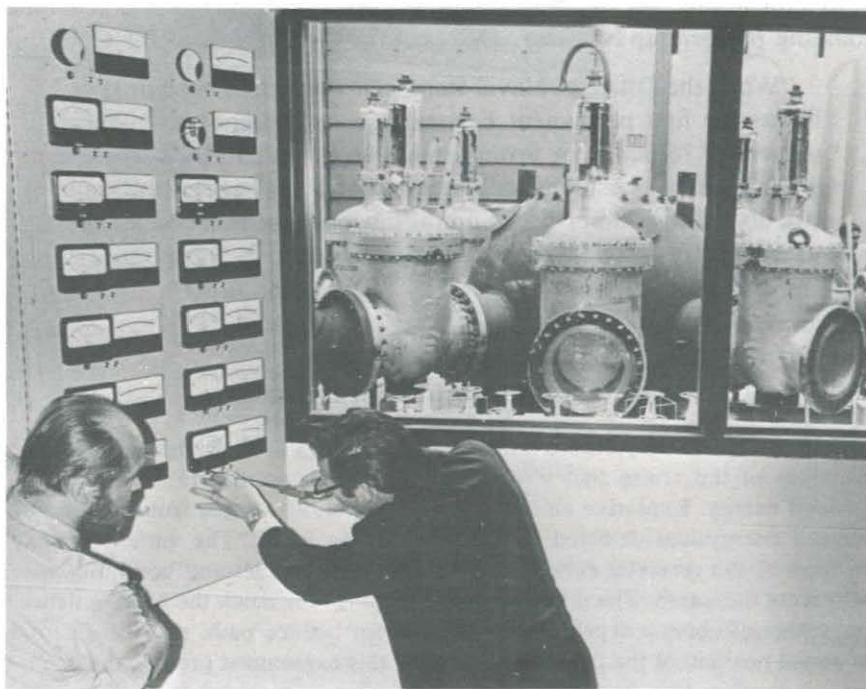


Figure 3 — The computer room looking into the main chamber

During the five years of building the facility, the researchers were not idle. Using the first chambers, the physiologists carried on research in various areas of high pressure life support, and during this time many graduate students received high pressure training while pursuing their advanced degrees. Research studies have been completed in a variety of areas. The toxic effects of various combinations of gases have been studied on rats, mice, guinea pigs and chinchillas, and the effects of pressure stress have been assessed on rats. A series of studies was completed, examining the stressors and their effects during decompression upon brain wave patterns, eye movements induced by vertigo and the learning behavior of small rodents.

The nutrition of animals kept in the bizarre environment found in hyperbaric work has been assessed through a long series of nutrition experiments, and the most appropriate temperature to bring the animals to thermal neutrality in these bizarre gas mixtures has been established. Studies of the microbiological changes that take place in this type of environment have begun. Several pharmacological studies have been carried out and are continuing, using the small chambers that eventually were incorporated in the main facility. Obviously, the majority of this work was done on a short-term (one-to-three day) experimental basis, looking forward to the day when animals can be placed in the hyperbaric chambers, to be maintained from six weeks to two years at pressure.

In concluding his address RADM Van Orden mentioned the long standing partnership between ONR and the universities of the Country.

"When the Office of Naval Research was established in 1946, it was the first permanent Federal agency designed to support university research. A firm partnership between ONR and the universities was established because the Navy recognized, as it still does today, that we rely on the campus research community to create the new ideas necessary to keep our Navy modern and effective."

FLIP Cruise on Barstur Range

FLIP has just completed a cruise on the BARSTUR Range. Among the objectives of the cruise that were met were studies applicable to fluctuations of sound energy. Explosive shots were fired at various ranges from FLIP. The received energy was detected by hydrophones on FLIP. The variation in the direction of the received energy between the surface duct and bottom bounce paths were measured. The purpose is to determine how much the bearing/deflection values of sonars, depending on the bottom bounce path, may be off from the actual position of the target. Not only did this experiment provide the important information described above, but assistance was provided to the Range for their calibration requirements.